Technical Recovery Criteria and Goals for Puget Sound Chinook Salmon and Bull Trout

Technical Recovery Criteria and Goals for Puget Sound Chinook Salmon

"I think science is important to this process because it helps describe the vision for what a recovered group of salmon in Puget Sound would look like, and it helps people decide how best to get there through their actions."

Mary Ruckelshaus, Chair; Puget Sound Technical Recovery Team

Introduction

Recovery plans prepared in response to a listing under the Endangered Species Act (ESA) are required to include, "objective, measurable criteria which, when met, would result in a determination.... that the species be removed from the list."   It is the Puget Sound Chinook Evolutionarily Significant Unit (ESU), not the individual Chinook populations, that constitutes the listed entity under the Endangered Species Act. A viable ESU is similar to a viable population — it is naturally self-sustaining and has a low risk of extinction. The time frame over which scientists evaluate the risk of extinction at the ESU level is a minimum of 100 years. In order to recover the region as a whole and meet criteria for de-listing, Puget Sound salmon recovery efforts must focus on the four viable salmon population parameters (abundance, productivity, spatial distribution and diversity) at both the population and ESU levels.

- Population Viability and Watershed Goals: The Puget Sound TRT (TRT) has used historical information and technical models to determine planning ranges for abundance and productivity that describe low risk (or viable) characteristics for each of the 22 independent Chinook populations in Puget Sound. The TRT also provided general guidelines for identifying spatial structure and diversity characteristics in low-risk populations. State and tribal co-managers concurrently developed a set of recovery targets for the abundance and productivity of individual populations. Utilizing this information, several watershed-based groups involved in salmon recovery planning have adopted measurable goals for the populations that spawn in their river systems. Some of the watershed groups have also developed methods to assess the spatial distribution and life history diversity of the populations within their local area.

- Viability at the ESU level: To ensure that the Puget Sound Chinook ESU will avoid extinction and persist past the next century, the region must reduce the risk that a catastrophic event such as a massive landslide, volcanic eruption or toxic spill will be devastating to Puget Sound Chinook, or will eliminate more of their unique genetic and life history traits. In other words, the ESU must be resilient to the potential effects of such an event. To accomplish this objective, five bio-geographical regions have been identified within the Puget Sound Chinook ESU. The recovery strategy is to ensure that there are multiple viable populations in each of the five regions to mitigate against catastrophic loss. Additionally, within each region, diverse life history characteristics of the different Chinook populations, such as run timing, rearing strategies, and size

Rebuilding a Viable ESU for Puget Sound Chinook Salmon
Technical Recovery Guidelines and Watershed Goals

22 Independent Chinook Populations
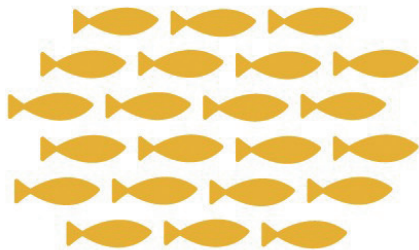
Planning ranges and targets for abundance and productivity associated with low-risk status were established for each of the populations. Watershed groups adopted measurable goals for the salmon populations in their watershed.

Each watershed area should strive for habitat of sufficient quality, quantity and connectivity to support salmon populations, and to provide opportunities for future habitat needs.

Each watershed should support some of the spatial distribution and diversity of life history traits that were historically present in their salmon population(s). The closer spatial distribution and diversity are to historical conditions, the lower the population risk.

### 5 Bio-Geographical Regions

Reduce the risk of further losses to Puget Sound Chinook by ensuring that some populations are thriving throughout the Sound.

5 bio-geographical regions were identified within Puget Sound based on similarities in environmental and biological conditions in marine, freshwater and terrestrial landscapes, and where there are common risks of catastrophe.

Genetic and life-history characteristics of salmon should reflect historical patterns across the region.

Nooksack   Hood Canal

South/Central

Strait of Juan de Fuca

Whidbey
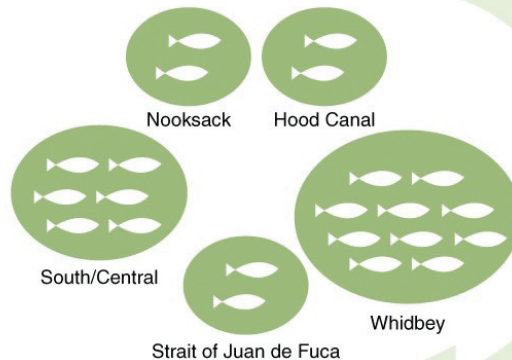
1 Viable Evolutionarily Significant Unit
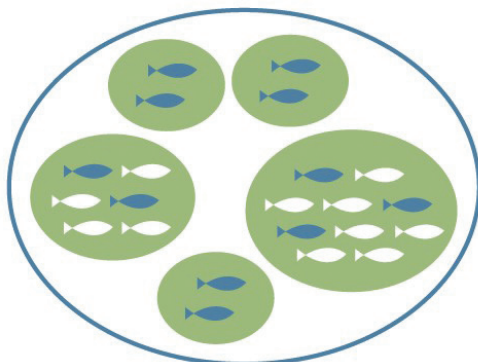
None of the remaining populations at a high risk of extinction.

At least 2-4 populations in each of the 5 regions achieve viable levels (low risk of extinction).

The five regions each have viable populations with life history traits that reflect historical patterns.

Habitat and population conditions across the region support future options for Chinook to rebuild.

Harvest, hatchery and habitat activities are consistent with ESU-wide recovery.

Puget Sound Chinook Salmon ESU

and age at return should be represented in each of the regions in a manner as similar to the historical structure as possible.

The achievement of viability for the entire Puget Sound Chinook ESU is the sum of these population and regional objectives, along with the preservation of future options for the Chinook in all salmon habitat types. The TRT has developed qualitative and quantitative guidelines for recovery and delisting of Puget Sound Chinook (PSTRT, 2002) that are described further in this section. Some of the key findings and recommendations include:

- To lower the risk of extinction of the Puget Sound Chinook ESU, all existing independent populations of Chinook salmon must show improvement from their current conditions, and some will need to attain a low risk status.

- To minimize the risk of a catastrophic loss, viable populations of Chinook salmon must be spread throughout the region. At least two to four populations in each of the 5 bio-geographical regions of Puget Sound must attain a low risk status.

- To minimize the further loss of genetic diversity and life history characteristics of Puget Sound Chinook, there should be at least one viable population from each major genetic and life history group in each of the 5 regions, based on the historical patterns present within that region.

The TRT recommendations also emphasize the need to maintain regional options for Chinook in the future. Habitat areas that are potentially used by Chinook but not presently used must be protected. Patches of habitat of an appropriate type and quality must be close enough together to provide "bridging points" to allow Chinook to colonize new areas and develop new traits over time. Populations that are not considered to be viable must not be allowed to go extinct.

Population Viability and Watershed Goals

Viable salmonid populations (VSP) and their habitat are the basic building blocks of a recovery plan. The TRT has identified four parameters to describe viability at the population level:

- Abundance: the size of the population (number of naturally spawning fish needed to ensure that the population persists over time)

- Productivity: how many fish are produced per adult spawner, or the overall population growth rate (how well the population replaces itself)

- Diversity: the variation in genetic, physiological, morphological and behavioral attributes (provide the fish with flexibility to adjust to changing environments)

- Spatial structure: the geographic distribution of fish at all life stages; needed to protect against a catastrophic loss in one location. This is important at both a river basin or population scale as well as a regional scale.

These four parameters are closely interrelated and together provide flexibility and buffer the risk of extinction in re-building and sustaining salmon populations. More information on VSP parameters is located in Chapter 2 of this plan.

Chinook Planning Ranges for Abundance and Productivity

The technical underpinnings of the recovery guidelines for the 22 independent Chinook salmon populations in Puget Sound are summarized in the 2002 report, "Planning Ranges and Preliminary Guidelines for the Delisting and Recovery of the Puget Sound Chinook Salmon Evolutionarily Significant Unit" by the TRT. Technical details of the population viability analysis and the development of the planning ranges are in process by the TRT as of this writing (spring 2005).

The TRT integrated the results from four different types of analysis to develop planning ranges

Applying VSP Parameters in Determining Population Viability

NMFS has developed guidelines to use in applying the four VSP parameters to salmonid populations for determining whether a population is viable. A complete description of these guidelines is included in "Viable Salmon Populations and the Recovery of Evolutionarily Significant Units" (McElhany et al, 2000); the following excerpts are included as examples. Uncertainty in data estimates for all four parameters must be taken into account.

Abundance:

• A population should be large enough to survive, and be resilient to, environmental variations and catastrophes such as fluctuations in ocean conditions, local contaminant spills or landslides.

• Population size must be sufficient to maintain genetic diversity.

Productivity:

• Natural productivity should be sufficient to reproduce the population at a level of abundance that is viable.

• A viable salmon population should not exhibit sustained declines that span multiple generations.

• A viable salmon population that includes naturally spawning hatchery-origin fish should exhibit sufficient productivity from spawners of natural origin to maintain the population without hatchery subsidy.

• Productivity should be sufficient throughout freshwater, estuarine and nearshore life stages to maintain viable abundance levels, even during poor ocean conditions.

Spatial Structure:

• Habitat patches should not be destroyed faster than they are naturally created.

• Human actions should not increase or decrease natural rates of straying among salmon sub-populations. Habitat patches should be close enough to allow the appropriate exchange of spawners and the expansion of a population into underused patches.

• Some habitat patches may operate as highly productive sources for population production and should be maintained.

• Due to the time lag between the appearance of empty habitat and its colonization by fish, some habitat patches should be maintained that appear to be suitable or marginally suitable, even if they currently contain no fish.

Diversity:

• Human-caused factors such as habitat changes, harvest pressures, artificial propagation and exotic species introduction should not substantially alter variation in traits such as run timing, age structure, size, fecundity (birth rate), morphology, behavior, and genetic characteristics.

• The rate of gene flow among populations should not be altered by human-caused factors.

• Natural processes that cause ecological variation should be maintained.

for abundance and growth rates of viable salmon populations in Puget Sound. Fishery records and biological data were utilized to estimate the historical sizes of salmon populations and the variability in the number of returning fish produced per spawner. Other analyses looked at the amount and condition of habitat in each watershed and its potential to support juvenile and adult Chinook. The TRT conducted population viability analyses using simple demographic models that predict the abundance and productivity needed for population persistence, given the natural variability in numbers over time. The TRT also included analyses conducted by the co-managers that used the Ecosystem Diagnosis and Treatment (EDT) model (Mobrand, Inc.) to predict fish abundance, productivity and diversity under different habitat conditions in each watershed. The EDT analyses utilized the concept of Properly Functioning Conditions (PFC) in evaluating the potential for habitat to support salmon abundance, productivity and diversity. PFC refers to the habitat conditions essential for conservation of the species, whether important for spawning, breeding, rearing, feeding, migration, sheltering, or other functions. These are described in the NMFS 4(d) rule (65 FR 170) and the "Matrix of Pathways and Indicators" (NMFS, 1996). Generally, properly functioning conditions are based on indicators such as water temperature, streambed sediment, hydrology, large woody debris, and chemical contaminants.

The TRT presented viable abundance and productivity estimates as a planning range - a broad estimate encompassing results from the different analyses that describes the abundance and productivity needed for a population to be viable over time. The ranges are large because of inherent variation in salmon populations, uncertainty in historical information, the fact that the required abundance depends upon the population's productivity, and differences among the analyses and models. A summary of the Puget Sound Chinook planning ranges for abundance and productivity is contained in Figure 4.1.

Chinook Planning Targets for Abundance / Productivity

State and Tribal fisheries co-managers also participated in the development of a set of planning targets to ensure that population viability was considered in evaluating harvest, hatchery and habitat measures. The targets are based on estimates of what salmon abundance can be supported by healthy salmon habitat at low productivity and high productivity. Figure 4.1 displays the planning ranges developed by the TRT, as well as the planning targets at low productivity and at the maximum productivity thought to be sustainable, given the habitat conditions assumed to be possible in each watershed. It is important to remember that the numbers represent different points along a population's performance curve, and that the planning targets seek to achieve the curve as average population performance over time. Population abundance and productivity will vary from year to year due to fluctuating environmental conditions.

The Shared Strategy approach relies on the work of individual watershed planning areas toward achieving independent population goals for their areas. Although the planning ranges and targets presented here are guidelines, several watershed groups have adopted measurable goals for the populations in their planning areas. (See watershed chapters.)

Spatial Structure at the Population Level

Spatial structure describes the geographic distribution of salmon within a population and, more broadly, across the habitat throughout the Puget Sound region. Spatial structure for a particular population generally refers to the distribution of individual fish in the habitats they use throughout their life cycle. The changing nature of habitat continuously affects the pattern of occupancy of salmon, but historically the structure of habitat provided essential features that enabled the salmon to disperse and adjust to habitat availability.

Populations	Mean spawner abundance for 1996 -2000	Low Productivity Planning Range for Abundance	Low Productivity[1] Planning Target for Abundance (productivity in parentheses)	High productivity[2] Planning Target for Abundance (productivity in parentheses)
NF Nooksack	120	16,000 – 26,000 (1.0)	16,000 (1.0)	3,800 (3.4)
SF Nooksack	200	9,100 – 13,000 (1.0)	9,100 (1.0)	2,000 (3.6)
Lower Skagit	2,300	16,000 – 22,000 (1.0)	16,000 (1.0)	3,900 (3.0)
Upper Skagit	8,920	17,000 – 35,000 (1.0)	26,000 (1.0)	5,380 (3.8)
Upper Cascade	330	1,200 – 1,700 (1.0)	1,200 (1.0)	290 (3.0)
Lower Sauk	660	5,600 – 7,800 (1.0)	5,600 (1.0)	1,400 (3.0)
Upper Sauk	370	3,000 – 4,200 (1.0)	3,030 (1.0)	750 (3.0)
Suiattle	420	600 – 800 (1.0)	610 (1.0)	160 (2.8)
NF Stillaguamish	660	18,000 – 24,000 (1.0)	18,000 (1.0)	4,000 (3.4)
SF Stillaguamish	240	15,000 – 20,000 (1.0)	15,000 (1.0)	3,600 (3.3)
Skykomish	1,700	17,000 – 51,000 (1.0)	39,000 (1.0)	8,700 (3.4)
Snoqualmie	1,200	17,000 – 33,000 (1.0)	25,000 (1.0)	5,500 (3.6)
N Lake WA/Sammamish	194*	4,000 – 6,500 (1.0)	4,000 (1.0)	1,000 (3.0)
Cedar	398*	8,200 – 13,000 (1.0)	8,200 (1.0)	2,000 (3.1)
Green	7,191*	17,000 – 37,700 (1.0)	27,000 (1.0)	Unknown
White	329*	Unknown	Unknown	Unknown
Puyallup	2,400	17,000 – 33,000 (1.0)	18,000 (1.0)	5,300 (2.3)
Nisqually	890	13,000 – 17,000 (1.0)	13,000 (1.0)	3,400 (3.0)
Skokomish	1,500*	Unknown	Unknown	Unknown
Mid-Hood Canal	389	5,200 – 8,300 (1.0)	5,200 (1.0)	1,300 (3.0)
Dungeness	123*	4,700 – 8,100 (1.0)	4,700 (1.0)	1,200 (3.0)
Elwha	1,319*	17,000 – 33,000 (1.0)	17,000 (1.0)	6,900 (4.6)
*Represents spawner escapement 1987 – 2001				

[1] The low productivity number in both the range and target represents one adult fish returning from the sea for each spawner, also called the equilibrium point (1:1)
[2] The high productivity number represents the number of spawners at the point where the population provides the highest sustainable yield for every spawner. The productivity ratio is in parentheses for each population and represents the relationship of fish returning from the sea for each spawner, (e.g. 3.4:1 for NF Nooksack)

Figure 4.1 Chinook Spawner Abundance Planning Targets & Ranges for Puget Sound Region. The numbers are presented for the populations for which analysis was available.

In assessing spatial structure within a population, the TRT recommended that human activities should not change the spatial structure in a way that significantly deviates from the historical pattern. The spatial distribution of habitat within a watershed must maintain enough quality, quantity and connectivity of habitat patches to support spawning, rearing, and upstream and downstream migration.

"The spatial and temporal distribution, quantity, and quality of habitat (landscape structure) dictate how effectively juvenile and adult salmon can bridge freshwater, estuarine, nearshore and marine habitat patches during their life cycle." (PSTRT, 2002)

Salmon transit a number of different habitats during their life cycle. Although a great deal of focus has been placed on restoring and protecting areas where they presently spawn, all of the freshwater, estuarine, nearshore and marine habitats that they utilize throughout their life are critical for survival and recovery.

Additionally, habitat options must be preserved for the future. Over time, salmon may re-colonize new areas due to increases in population abundance, their ability to once again access areas where habitat was formerly blocked or degraded, or because their present habitat areas are suffering a decline in quality from human or natural causes. The risk of extinction for Puget Sound salmon populations is thus affected by the quality, quantity

and geographic structure of habitat now, and in the future. Some habitats not used today may be very important tomorrow and thus must be preserved. Spatial structure also can be threatened by excessive predation, competition, harvest, or hatchery practices in key rearing or spawning habitats.

Areas used by salmon that affect their viability and risk of extinction include:

- Presently delineated spawning habitat for the 22 independent populations of Chinook salmon in the Puget Sound ESU;

- Freshwater spawning habitat in other watersheds of Puget Sound;

- Freshwater habitats supporting juvenile rearing and the downstream and upstream migration pathways; and

- Estuarine and nearshore habitat supporting forage production, rearing and migration of juveniles and adults.

Smaller, independent tributaries, estuaries and nearshore habitats must support functions and conditions that do not impede ESU viability. For example, runoff from freshwater tributaries affects nearshore habitats, smaller freshwater tributaries are occasionally used by adults, and both juveniles and adults rear in and migrate through estuarine and nearshore habitats.

Diversity at the Population Level

"Diversity is important to population viability since more diverse populations are better buffered against changes in environmental conditions" (PSTRT, 2002).

The differences in genetic structure within and between populations, the range of adult size and appearance, the variability and spread in the time that fish return to the river to spawn, the range in age at return, the variety of behaviors and other traits are all important aspects of diversity. Salmon populations exhibit this variation today, and this

diversity helps them "hedge their bets" against uncertain and variable environmental conditions. The TRT has emphasized the importance of retaining or restoring the historic pattern of diversity within populations to reduce extinction risk.

Metrics for Spatial Structure and Diversity at the Population Level

Quantitative viability criteria for spatial structure and diversity are largely unavailable at the population level. As discussed in the previous section, the TRT provided watersheds with general guidance for the importance of spatial structure and diversity, and gave examples of different ways to indicate these population attributes using existing data. Some watersheds such as the Snohomish have applied some of the TRT examples of "metrics" for evaluating these parameters to their populations. By mapping the current and historical use of sub-watersheds for adult spawning and juvenile rearing, they have been able to look at the separation of habitat types and the types of habitats the fish can access under different watershed conditions (figure 4.2). This information can be used to compare the effect of alternative land use proposals on habitat diversity and the spatial structure of the local salmon population. The EDT model, used in many watersheds to estimate population abundance and productivity, can also summarize changes in life history diversity relative to the historical condition.

ESU-Wide Delisting and Recovery Criteria

Scientists from the TRT and elsewhere believe that Puget Sound was once home to more populations of Chinook with greater diversity than what presently remains. It is estimated that at least 11 to 15 populations of Chinook salmon in Puget Sound have already been extirpated, and most of them were from early timed runs (NMFS/BRT, 1997; PSTRT, 2005). The disproportionate loss of early-run life history diversity is a major loss to the genetic and evolutionary legacy of the ESU, and
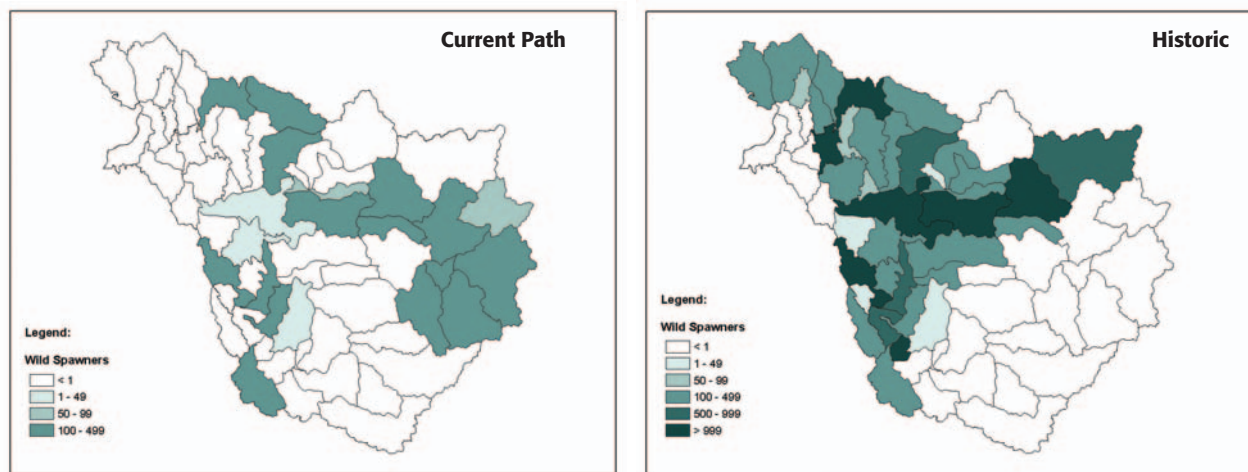
Figure 4.2 Map depicting the change in number of wild spawners in the Snoqualmie and Skykomish populations in the Snohomish River basin. Results are from SHIRAZ modeling. Maps created by K. Bartz, NOAA Fisheries' NWFSC.

recovery guidelines strive to reduce the risk that the region will have further loss.

Recovery criteria for Puget Sound Chinook are described in "Planning Ranges and Preliminary Guidelines for the Delisting and Recovery of the Puget Sound Chinook Salmon Evolutionarily Significant Unit" (PSTRT, 2002). ESU level viability guidelines consider the risk of catastrophes and the preservation of historical genetic, life history and geographic diversity across the ESU.

Summary of ESU Recovery Criteria and Technical Guidance

The ESU-wide delisting and recovery criteria (PSTRT, 2002) provide flexibility in meeting the requirements of the Endangered Species Act, and preserve options for Puget Sound Chinook in the future. The recommendations by the TRT describe the biological characteristics that would constitute a viable ESU for Puget Sound Chinook. The ESU would have a high likelihood of persistence if:

1. All populations improve in status and at least some achieve a low risk status.

2. At least 2-4 viable Chinook populations are present in each of the 5 regions.

3. Each region has one or more viable populations from each major diversity group that was historically present within that region.

4. Freshwater tributary habitats in Puget Sound are providing sufficient function for ESU persistence. Ecological functioning occurs even in those habitats that do not currently support any of the 22 identified Chinook populations, since they affect nearshore processes and may provide future habitat options.

5. The production of Chinook salmon in Puget Sound tributaries is consistent with ESU recovery objectives, and contributes to the health of the overall ecosystem in the region.

6. None of the 22 remaining Chinook populations go extinct, and the direct and indirect effects of habitat, harvest and hatchery management actions are consistent with ESU recovery.

Population Abundance Risk Levels

The planning ranges for the independent Chinook populations cumulatively affect the level of the risk of extinction for the ESU as a whole. In attaining viability at the ESU scale, it is expected that the individual populations will show different levels of risk, but they must be considered in the aggregate. Although some of the Puget Sound Chinook populations have shown substantial progress in recent years, none of the 22 populations are presently close to meeting the minimum value of the viable planning range for abundance and productivity, all

are considered to be at high risk, and the condition of all of the populations needs to improve.

The TRT has indicated that it is not necessary for every single one of the individual populations to attain a low risk of extinction (i.e. fall within the planning range for both abundance and productivity) to achieve ESU-wide viability. However, at least some of the populations must recover well above the minimum threshold of the viable planning range since, "an ESU-wide scenario with all populations at the lower end of the planning range for viability is unlikely to assure persistence and delisting of the ESU." (PSTRT, 2002)

Figure 4.3 shows a conceptual diagram illustrating how the level of risk may vary across the aggregate of salmon populations. Risk considerations include the biological characteristics of the individual population as well as the habitat status of each watershed, the ability to exercise treaty fishing rights, comprehensive re-building programs using artificial propagation, and other considerations.

Populations that do not meet the low-risk criteria for abundance, productivity, and other VSP parameters must be sustained to preserve options for future recovery at the ESU scale. Additionally, habi-tat, harvest and hatchery management must pay particular attention to the effect of their actions on individual populations which remain at moderate or high risk of extinction.

Geographic Distribution of Risk

The threat that a catastrophic event will wipe out a large group of salmon and the need to preserve diversity throughout the ESU must also be considered when evaluating the risk of extinction at the ESU level. To incorporate these concerns, the TRT identified five bio-geographical regions within Puget Sound based on similarities in physical and habitat features, and where groups of Chinook have evolved in common. (Figure 4.4 and 4.5) Physical factors included topography (upland and marine bathymetry), major mountain ranges or other geologic features, ecological variation, of vegetation and biotic communities. The regions also correspond to locations where groups of populations would be at common risk from a potential disaster such as a volcanic eruption, toxic contamination, or an oil spill. Similarities and differences between the genetic and life-history composition of the salmon populations in the ESU were also evaluated.

Notes: Risk considerations include:
• Biological characteristics of population
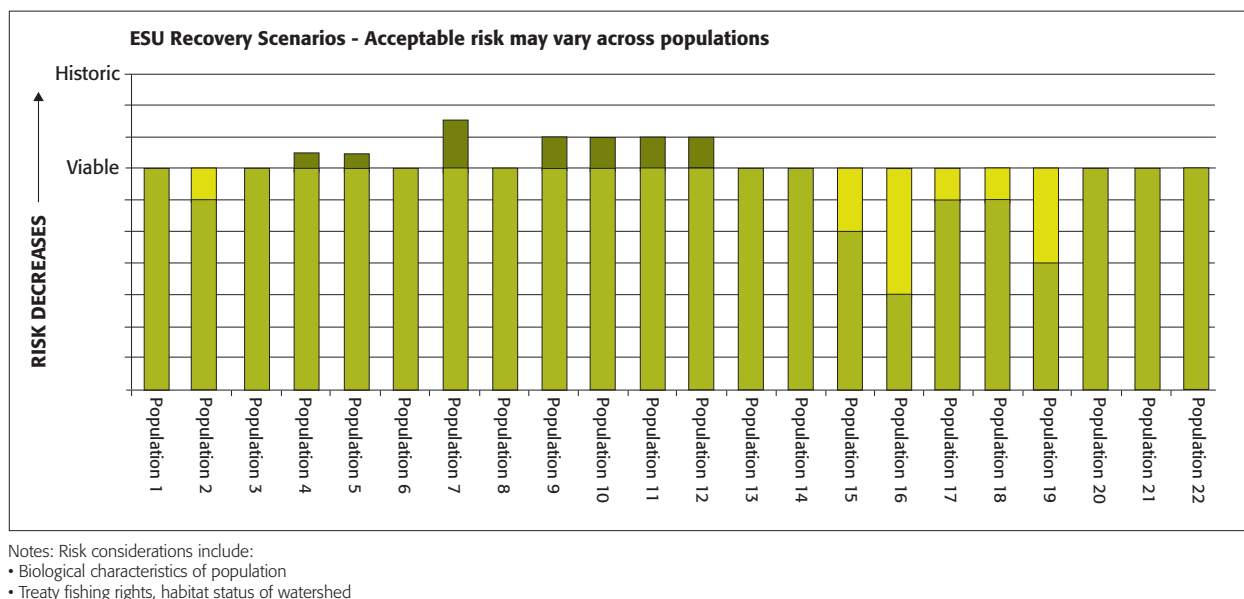• Treaty fishing rights, habitat status of watershed

Figure 4.3 Conceptual diagram that illustrates the level of risk may vary across the aggregate of salmon populations. Source: PSTRT & Mary Ruckelshaus.

Figure 4.4 Independent populations of Chinook salmon in the Puget Sound grouped according to geographic regions of diversity and risk. Map courtesy the PSTRT & Mary Ruckelshaus.

Geographic Region	Populations Remaining
Strait of Georgia This area includes the Nooksack River and the San Juan Islands. It is an area greatly influenced by the Fraser River and is utilized extensively for forage and migration by many Puget Sound populations.	North Fork Nooksack South Fork Nooksack
Strait of Juan de Fuca This region includes the rivers draining the north slopes of the Olympic mountains, and draining into the eastern Strait of Juan de Fuca. Nearshore areas along the Strait are considered to be a major migratory corridor.	Elwha Dungeness
Hood Canal The east face of the Olympic mountain range and small streams along the western Kitsap Peninsula drain into this distinct estuary.	Skokomish Mid Hood Canal (incl. Dosewallips, Duckabush and Hamma Hamma)
Whidbey Basin The Whidbey basin is the main estuarine area for the major Chinook-producing rivers in Puget Sound, and the migratory crossroads for most Puget Sound populations.	Skykomish Snoqualmie North and South Fork Stillaguamish Upper and Lower Skagit Upper and Lower Sauk Suiattle Cascade
Central/South Basin These basins were combined into a single geographic unit largely to reflect correlated risks from volcanic activity and urban-related effects.	Cedar River North Lake Washington Green/Duwamish Puyallup White Nisqually

Figure 4.5

Within each of the five bio-geographical regions, the TRT has recommended that:

"An ESU-wide recovery scenario should include at least 2-4 viable Chinook salmon populations in each of 5 geographic regions within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region." (PSTRT, 2002)

Geographic Distribution of Diversity

The loss of any additional genetic and life history characteristics from the Puget Sound ESU will affect the ability of the Chinook salmon to persist in the future. The guidelines for recovery at the ESU level thus include a recommendation to achieve a low risk of extinction for populations that represent the scope of genetic and life history types in all five regions.

"An ESU-wide recovery scenario should include within each geographic region one or more viable population from each major genetic and life history group historically present within that geographic region." (PSTRT, 2002)

Figure 4.6 illustrates the major diversity types of Chinook in Puget Sound based on suites of interrelated life history traits (e.g., run-timing, age-at-outmigration, length-at-age). Early-run Chinook generally enter the river system in April and May and spawn in late August and September, while late-run Chinook enter their natal stream in the late summer months and spawn in the fall. Several stocks of early-run Chinook have already become extinct in the Puget Sound region. The recovery guidelines from the TRT thus emphasize the preservation of the life-history types still remaining in the bio-geographical regions.

Although the TRT has been developing separate criteria for each of the four VSP parameters, it is important to recognize that all four are closely inter-related, and short term improvements to one factor may positively or negatively impact the others. For example, opening additional habitat areas is likely to benefit both abundance and spatial structure. However, in some river systems it may be necessary to provide opportunities for Chinook to occupy habitats that are not as productive in order to meet spatial and diversity criteria in the long term. TRT guidelines are primarily directed at reducing the risk of extinction and preserving options for the future of the Puget Sound Chinook ESU.

Major diversity types in extant and extirpated populations of Chinook in Puget Sound
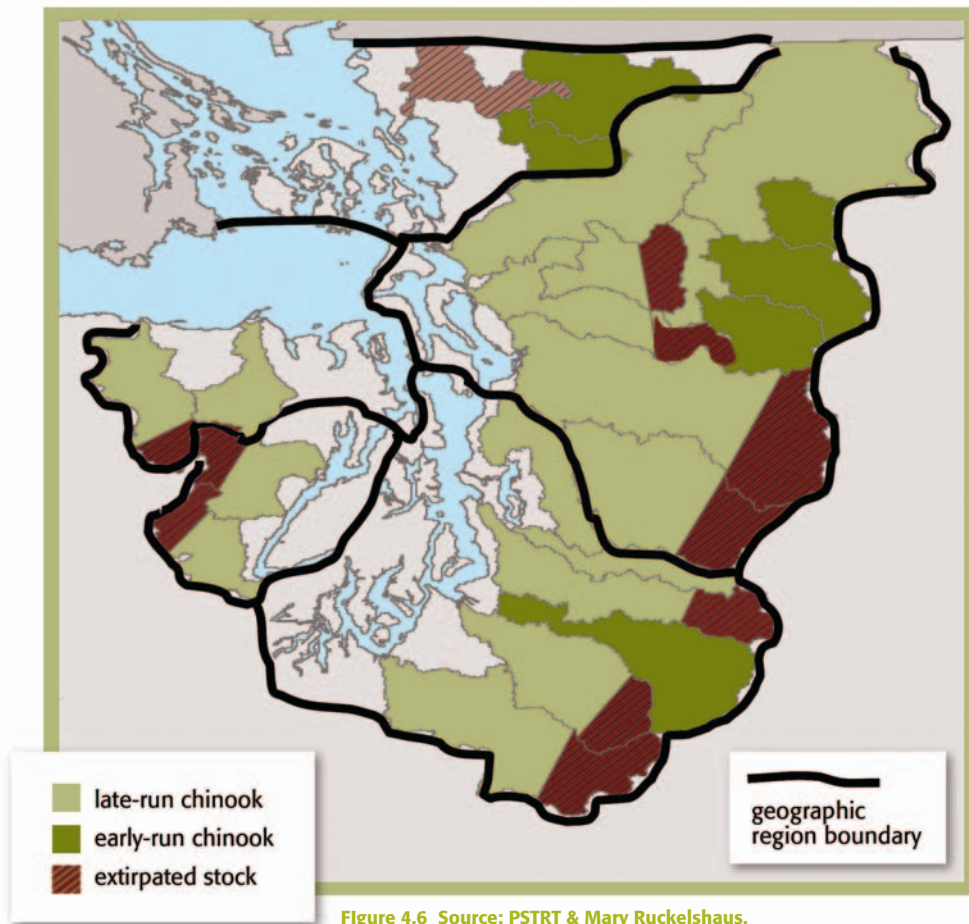

late-run chinook
early-run chinook
extirpated stock

geographic region boundary

Figure 4.6 Source: PSTRT & Mary Ruckelshaus.

Technical Recovery Criteria and Goals for the Coastal/Puget Sound Bull Trout Distinct Population Segment

"In keeping with the goal of fostering effective management and recovery of bull trout at the local level, we have developed ... specific recovery targets for each management unit that will be used to guide bull trout recovery... as a whole."

U.S. Fish and Wildlife Service, 2004

Introduction

Bull trout were listed as a threatened species in 1999 throughout their range in the coterminous United States. Because listing occurred at that level, currently delisting can only occur at the coterminous level as well. However, if additional information and rules determine that the Coastal-Puget Sound Distinct Population Segment of bull trout may be considered separately, delisting may be considered once the DPS has achieved a recovered state.

USFWS has stated the goal of their recovery plan is, *"to ensure the long-term persistence of self-sustaining, complex interacting groups of bull trout distributed across the Coastal-Puget Sound Distinct Population Segment, so that the species can be delisted."* (USFWS, 2004)

Recovery criteria and targets for the Coastal-Puget Sound Distinct Population Segment are structured around the parameters of abundance, productivity, distribution and connectivity of bull trout, including the potential for the full expression of life history traits.

Recovery Criteria

Essential to the recovery of bull trout are complex interacting groups - multiple local populations within a geographic area that have suitable opportunities and conditions to move freely upstream and downstream to interact with one another. Criteria for recovery of bull trout in the Coastal-Puget Sound DPS include the following conditions:

1. Biological and ecological function of the 14 identified core areas (6 in the Olympic Peninsula Management Unit and 8 in the Puget Sound Management Unit). Components of fully functioning core areas include:

   - Habitat that provides for the persistence of broadly distributed local populations supporting the migratory life history form within each area.
   - Adult bull trout are sufficiently abundant to provide for persistence and viability. This level of abundance is estimated to be 16,500 adult bull trout across all core areas in the Coastal-Puget Sound DPS.

- Measures of bull trout abundance within all core areas show stable or increasing trends, based on 10 to 15 years of monitoring data (represents at least 2 bull trout generations).

- Habitat within and between core areas is connected sufficiently to provide for the full expression of migratory behavior, re-colonization of areas that were previously extirpated, and provide for potential genetic exchange between populations.

2. A monitoring plan has been developed and is ready for implementation, to ensure the ongoing recovery of the species and the continuing effectiveness of management actions. The plan must cover a minimum of 5 years post-delisting.

Recovery Targets

The Recovery Plan for the Coastal/Puget Sound bull trout DPS (USFWS, 2004) outlines the following recovery targets.

Distribution

Maintain or expand the current distribution of bull trout in identified core areas (within United States waters).

Puget Sound Management Unit: This unit contains 8 identified core areas with 57 identified local populations which will be used as a measure of broadly distributed spawning and rearing habitat within these core areas. The distribution within the five additional potential populations that have been identified should also be confirmed or restored.

Olympic Peninsula Management Unit: This unit contains 6 core areas with 10 currently identified local populations. These populations will be used as a measure of broadly distributed spawning and rearing habitat within these core areas. Spawning distribution in the two potential local

populations that are essential to recovery should be restored or confirmed.

Abundance

Recovery targets are based on the abundance needed to reduce the likelihood of genetic drift and consideration of surveyed fish densities, habitats, and potential fish production after threats have been addressed.

Puget Sound Management Unit: Achieve minimum estimated abundance of at least 10,800 adult bull trout spawners among all core areas in the Puget Sound Management Unit. Recovered abundance targets are as follows:

Core Area	Recovered Abundance Target
Chilliwack	600
Nooksack	2,000
Lower Skagit	3,800
Upper Skagit	1,400
Stillaguamish	1,000
Snohomish-Skykomish	500
Chester-Morse Lake	500
Puyallup	1,000

Olympic Peninsula Management Unit: Achieve minimum estimated abundance of at least 5,700 adult bull trout spawners, including at least 1,000 spawning adults in each of the Dungeness, Elwha, Hoh, Queets, and Quinault core areas and at least 700 spawning adults in the Skokomish core area.

Productivity

Restore adult bull trout to exhibit stable or increasing trends in abundance at or above the recovered abundance target level based on 10 to 15 years of monitoring data (representing at least 2 bull trout generations).

Connectivity

Restore connectivity by identifying and addressing specific existing and potential barriers to bull trout movement. Connectivity criteria will be met when intact migratory corridors are present among

all local populations within each core area, thus providing opportunity for genetic exchange and life history diversity. The achievement of distribution, abundance and productivity targets is expected to depend on providing passage at barriers throughout all of the core areas in the Coastal/Puget Sound distinct population segment of bull trout.

More information on the proposed recovery actions, research needs, timelines and costs of recovery are contained in the Draft Recovery Plan for the coastal-Puget Sound Distinct Population Segment of Bull Trout (USFWS, 2004).

References:

Section 1:

Federal Register; January 3, 2000. Proposed 4(d) Rule Governing Take for Puget Sound Chinook and Hood Canal Summer Chum. 65 FR 170.

McElhany, P., M. Ruckelshaus, M.J. Ford, T. Wainwright and E. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Dept. Commerce, NOAA Tech. Memorandum NMFS-NWFWC-42, 156 pp.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

National Marine Fisheries Service (NMFS). 1996. Making ESA Determinations of Effect for Individual or Grouped Actions at the Watershed Scale. Environmental and Technical Services Division, Habitat Conservation Branch. Portland, Oregon.

National Marine Fisheries Service; West Coast Chinook Salmon Biological Review Team, 2003. Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead. Available from the NMFS Northwest Fisheries Science Center; Seattle, WA.

Puget Sound Technical Recovery Team, 2002. Planning Ranges and Preliminary Guidelines for the Delisting and Recovery of the Puget Sound Chinook Salmon Evolutionarily Significant Unit. Draft report available from the Northwest Fisheries Science Center; Seattle, Washington. [NOTE: THIS IS THE "BLUE PAPER"]

Puget Sound Technical Recovery Team. 2003. Integrated Recovery Planning for Listed Salmon: Technical Guidance for Watershed Groups in Puget Sound. Draft report available from the Northwest Fisheries Science Center; Seattle, Washington.

Puget Sound Technical Recovery Team. February 17, 2004. Combining Demographic and Habitat-based Approaches to Triangulate on Viability Criteria for Puget Sound Chinook salmon Populations... Draft report available from the Northwest Fisheries Science Center; Seattle, Washington.

Puget Sound Technical Recovery Team. June 21, 2004. ESU Viability Criteria for the Puget Sound Chinook Evolutionarily Significant Unit. Draft report available from the Northwest Fisheries Science Center; Seattle, Washington.

Puget Sound Technical Recovery Team, 2005. Independent Populations of Chinook Salmon in Puget Sound. Draft report available from the Northwest Fisheries Science Center; Seattle, Washington.

Section 2:

U.S. Fish and Wildlife Service, 2004. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (Salvelinus confluentus). Available from U.S. Fish and Wildlife Service Region 1; Portland, OR.